1. Administrative

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HAWAIIAN SEASCAPES AND THEIR MANAGEMENT IMPLICATIONS

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2. Public Summary

The study of seascapes, the area where humans interact with the ocean, and particularly, how people ascribe meaning to their observations, interactions, and relationships to the sea is directly pertinent to the management of our ocean resources. Through our interviews with respected ocean users we learned the difficulties and potential of mapping ocean currents and ocean use areas and how these ocean experts have perceived change in the environment. In Hilo Hawaiʻi, we interviewed ocean experts (people recommended for the ocean knowledge), and surfers of all ages and experience at Honoliʻi. We also collected physical environmental data for Hilo Bay and ocean user presence counts for beaches within this County. Understanding the dynamics of the seascape in a manner that supports management decision-making requires us to understand the complex interactions between human, biological, and physical processes. We mapped the changes in oceanic conditions through time as monitored by environmental sensors and the perception of this change as reflected in personal interactions with a site through time. Changes in the environment cannot be perceived only through the measurement of single variables, but must be placed within a social context of complex changes. Through the interviews we can see a pattern of seacape delineation, scales of interactions, and personal connections with the ocean. Ocean experts' spatial observations are determined by their activities on the ocean as well as ecological boundaries. Change over time in a specific place is defined by biological and physical changes, external social pressures, and individual reflections, preventing ocean observers from specifically identifying the effects of climate change yet allowing their connection to place to continue. Exposing managers to the application of alternative data sources and particularly human perceptions expands the ability of managers to align discussions around scales relevant for ocean users.

3. Technical Summary

The goal of this research and the corresponding achievements were to:

- Describe a range of biophysical processes in the Hilo marine environment,
- Describe how Hilo Bay has been and is being used,
- Couple sensor-based data with community insight, and

- Quantify and test methods for describing how and why different ocean user groups socially construct and delineate marine space.

We achieved each of our goals through socially inclusive methods of in-person interviews, written surveys, and digitization of historical records. Maps of oceanic processes were produced, but more importantly was the analysis of the methods in understanding the feasibility of studying such ocean knowledge. We gained an appreciation of community insight into climate trends such that communication of climate change impacts and change can be understood.

Figures specific to Hilo were produced from wave buoys, wind, rain, stream flow and sea level measurements. These data were presented and discussed alongside qualitative information of the environment with community members to create a holistic picture of the past, present, and future conditions of Hilo Bay. Through surveys and interviews with ocean users, we began to map out the frequency of activities within Hilo Bay and understanding the importance of the Hilo ocean environment to this coastal community. By working within this oceanic community we are able to infer future characteristics of the Hilo marine environment, both socially and physically, allowing us to proactively involve the community in discussions relating to climate change impacts on Hilo Bay.

Although we were excited about the place specific ocean user surveys results, our publication highlighted the practicality and feasibility of integrating local knowledge within a scientific context. The range of ability and methods in which ocean experts communicate their ocean knowledge was discussed to highlight the complexity of accessing ocean expert knowledge. The integration of local and western science is largely lauded as important yet projects which demonstrate the products of such integration are few. We discussed not only the ability to integrate these knowledge systems but how the scale of projects should be user defined and not based on limitations/design of sensors to ensure that the products created can be utilized by a greater community. Understanding the scale at which products generated by science relate to the scale at which ocean users interact with the ocean will allow cross-conversations to develop.

Examples of projects that have successfully documented local knowledge regarding environmental characteristics are scarce in relation to the amount of local knowledge accessed for biological variables such as birds and plants. However, by working with a community that directly relies on environmental conditions to complete their objective, such as surfers, we can start understanding not only the variables they observe, but also how they characterize conditions. Globally, there has been a lot of research on surf culture and values, but there is relatively little written regarding the knowledge that surfers gain regarding the ocean. We discovered that the physical conditions that create good surf are uniformly identified by surfers regardless of skill or experience for a particular surf spot. They are able to mentally model the conditions that create good surf at a site, including wind conditions, wave direction, wave height, tides and river flow. Yet, this data defines just the physical surf conditions, and along with this data they also construct the social conditions present, such as amount of surfers in the water, skill of surfers, gender and age, and overall weather conditions. The complexity of understanding good environmental conditions in which to surf means that predicting the effects of climate change on ocean recreation is not based simply on the physical changes of the ocean but must also incorporate changing social norms.

Understanding Hawaiian seascapes and their management implications through the integration of physical and social science products created results that are both important in understanding future climate change impacts here in Hawai‘i but also successfully furthered the discussion for theoretical dialogue regarding integration of knowledge systems and defining ocean epistemologies. Success in management requires understanding our communities‘ perceptions and needs and we must move beyond studying only the physical parameters to learn how environmental changes are internalized by those with intimate understanding and dependence on these resources.

4. Purpose and Objectives

Coastal systems worldwide are areas of high productivity that contribute considerably to well-being of coastal communities. Understanding the dynamics of these areas in a manner that supports management decision-making, however, remains difficult given the complex interactions between human, biological and physical processes. In Hawaii, an entirely coastal state, near shore processes are vastly understudied yet are undergoing constant flux under changing current climatic conditions. Through research we not only wanted to learn more about the issues facing these ecosystems, but also learn from the communities that interact daily with the ocean while sharing with them the science of climate change. The research group included the principal investigator as well as students and early career professionals. We were able to work with a majority of surfers at Honoli‘i as well as many respected ocean users along Hilo Bay. The interviews and maps recorded are only a start to understanding the seascapes of Hawai‘i yet the processes have been refined as well as recognition of the value of the research and results.

We answered the goals of the research through four different methodological approaches as outlined in the next section. Each of these methods assisted us in meeting our objectives to understand the people and processes in Hilo Bay from both quantitative and qualitative perspectives. Only by including human perceptions can we begin to understand the implications of climate change on a particular demographic. This research did not attempt to provide strategies for climate change adaptation, instead focus was placed on testing methods to understand the feasibility of collecting and integrating qualitative information to be used in management decisions. Although modifications were not necessary to achieve our results, the inclusion of students from our target communities allowed for easier dialogue then hiring of professionally trained staff as was originally targeted.

5. Organization and Approach

Noelani Puniwai was the active project investigator for the Hawaiian Seascapes project. She has been assisted by a student (Aloha Kapono), two intermittent employees (Ayesha Genz & Lisa Canale), and various interns. Cherie Kauahi was brought on board in Year 2 to help with research goals, and Caleena Au, Valerie Pertabal, Kesusa Marques, Haleaka Kiili, and Daynia Au-Maruyama were essential for data entry and transcribing interviews. Dr. Puniwai oversaw all project activities and budget allocations.

To understand Hawaiian seascapes, there were four main avenues of data collection, each attempting to answer similar questions but with a different solicitation method.

1. Ocean experts were presented with maps in which to describe site-specific ocean currents knowledge. Each of these in-depth interviews were transcribed and analyzed (n=30). Digitization and geo-referencing of all maps were completed by Lisa Canale.

2. An 8-page survey was distributed to surfers at Honoli‘i Bay in-person to gain a perspective of a wide demographic range of ocean users in particular to a specific place (n=104).
3. Digitization of Hawaii County Ocean User Safety observations from 2007 from physical copies and digital records to a single database prepared for analysis will be completed but was started with PICSC funding.
4. Interviews with ocean-related individuals to understand a broader definition of ocean culture and the importance or relationship that the ocean has to people globally were conducted in summer 2016 with a colleague from La Rochelle University (Dr. Camille Parrain; La Rochelle France). All interviews were transcribed and archived for future analysis and comparisons (n=9).

6. Project Results

Our inquiry into Hawaiian Seascapes yielded some unique results as well as insights into future research. The results are summarized below in response to the four data collection methods presented above. For more detailed understanding of results please see the resulting publications.

1. Ocean observer interviews

i. Ocean experts were easily identified by the PI using snowball techniques within well-defined communities because trust has been fostered between researchers and ocean experts over time.
ii. Individuals with ocean expertise have many different ways in which they are comfortable and able to communicate their knowledge of oceanic processes. Forcing observers to physically draw on printed maps was not practical nor productive for some observers obliging researchers to adjust methods based on ocean observers’ preference.
iii. Ocean observers mentally map processes at different physical scales, which may be predicted by ocean activity type; Table 1.
iv. Stories are unique to the individual, and current maps may be difficult to interpret without the accompanying dialogue, i.e., Understanding the story is necessary to decipher each map. Additionally, “stories” cannot be summed to create a larger novel. A novel needs to be written through the concurrent dialogue of ocean experts (group mapping); Fig 1(a).
v. Comparisons of ocean observation scales with those collected by the Doppler radars and created by models show the spatial overlap and gaps in knowledge; Fig 1(b).

Table 1. Scale of maps selected and annotated by ocean observers (n = 19).

Ocean Observers (n)	Amount and Scale of Selected Maps
Surfer (6)	1:5,000 (8), 1:20,000 (3)
Fisher (5)	1:5,000 (2), 1:20,000 (7), 1:40,000 (15)
Paddler (4)	1:5,000 (3), 1:10,000 (4), 1:20,000, (6), 1:100,000 (2)
Sailor (2)	1:5,000 (1), 1:20,000 (2)
Other Waterman (2)	1:5,000 (2), 1:20,000 (1)

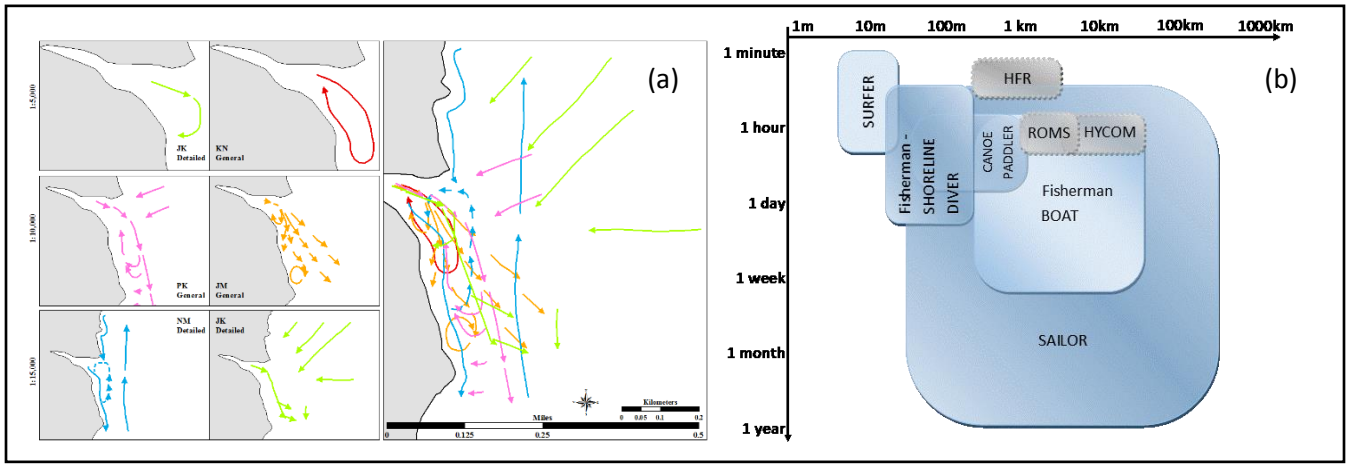

Figure 1(a) Observations of currents in Honoli'i, Hawai'i as mapped by ocean observers (n=5). Each color represents a single ocean expert. (b) Resolution of initial observations by ocean observers; Gray - observations made by mechanical devices (HFR – high frequency radar); ROMS – Regional Ocean Modeling System; HYCOM – Hybrid Coordinate Ocean Model), blue represents human observations.

2. Climate change as observed by surfers

i. Surfers at Honoli'i had a preference for surf quality based on swell direction, wind strength and direction, and height, which was highly concurrent. Their preference for particular surf conditions were consistent regardless of demographics, skill, or commitment to surfing.

ii. When presented with forecasts of a range of weather and climate predictions, surfers generally expect little to no change in surf quality irrespective of surfer demographics, skill, or commitment (Fig 2). Surf quality was predicted to decrease if smaller wave heights and less consistent trade winds are expected and increase in result of large extreme wave events.

iii. Surf quality, both the physical and social components of surfing, are evaluated in defining the surf culture of a place. Physical wave preferences do not alone predict surf quality.

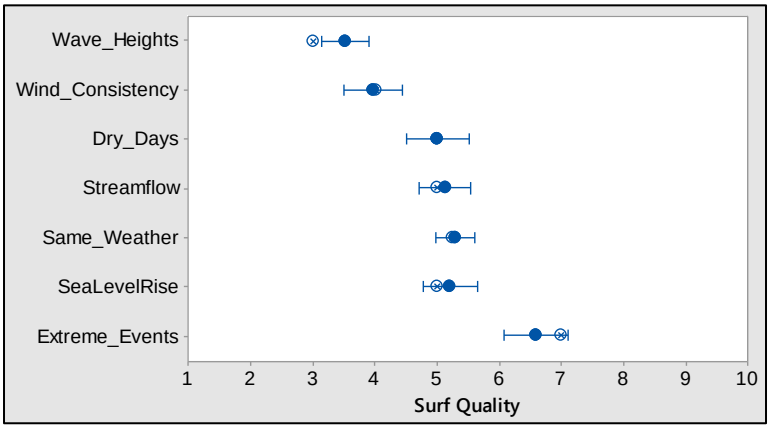

*Figure 2. Forecast of future surf quality at Honoli'i based on seven predictions (n = 77-89). Surf quality was ranked from 1 (decreasing surf quality) to 10 (increasing surf quality). * values denote p values significantly different from a no change value of 5.5*

3. County of Hawaii Ocean User Safety Sheets

i. Digitization and preparation for analysis was completed for the County of Hawai‘i ocean user counts for the years 2007-2015 for the following County parks: Honoli‘i, Onekahakaha, Richardsons Ocean Center, Ahalanui, Leleiwi, Carlsmith. Additional information was also digitized as available for Laaloa, Isaac Hale, Kahaluu and Punaluu.

ii. Time analysis of ocean users at Honolii was graphed in comparison to the perspectives of surfers at Honoli‘i.

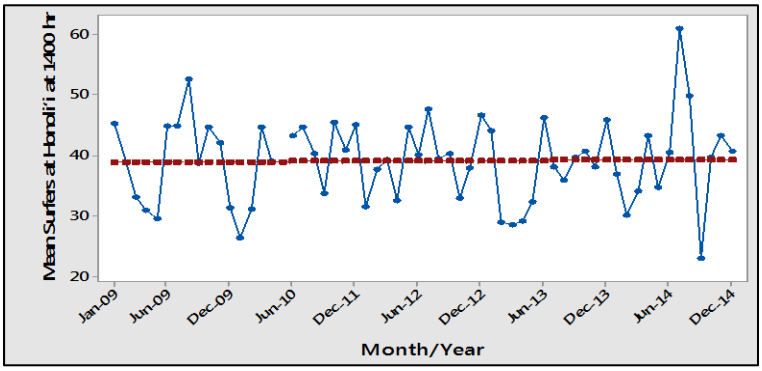

Figure 3. Daily presence at 2:00pm of surfers at Honoli‘i from June 2009 through December 2014 as observed by County of Hawaii Ocean Safety Officers.

4. Definition of Seascapes

i. We assembled concepts of seacapes from ocean users of all ages in Hawaii (n=13) through an 8 page in-person structured interview and follow-up focus group discussions.

ii. A very different ocean connection was documented in comparison to seascape research completed in the Atlantic Ocean. The definition of where the ocean “begins”, “why” the ocean is important to us as individuals, and the markers used at sea are some highlighted differences that still need to be summarized/analyzed.

7. Analysis and Findings

Research into Hawaiian Seascapes was successfully implemented, and the foundation for future research and strategies for integration into management has been established. Two major publications were drafted in conclusion of this work, and one more publication is being written to be submitted in the future. In reference to the results displayed above, we are very excited about the accomplishments that these simple methods have produced.

1. *Ocean observer interviews* - We have shown that the digitization of ocean currents through qualitative methods can yield interesting insights. The context in which regular ocean users operate on the ocean help them understand different patterns and “places” that are not mapped or otherwise documented through traditional oceanographic methods. These areas are commonly known and accessed and exist at multiple spatial and temporal scales. Yet we have also shown that not all ocean experts communicate their knowledge in the same methods and at the same depth and breadth. Methods to understand local knowledge must be adaptive to each ocean expert to include verbal, mental, mapping, or physical techniques. Managers who wish to

understand the local knowledge of ocean processes must be flexible when defining spatial and temporal scales of interest to reflect the expertise and interest of ocean users. If managers wish to directly acknowledge and integrate ocean user knowledge pertaining to specific coastlines or activities, the simplicity of qualitative, in-person techniques can have significant results while also gaining stakeholder involvement, and building trust with the respective ocean community.

2. *Surfers' perception of climate change* – How one perceives the environment is a reflection of reality that results in understanding or action. Surfers perceive environmental change in their interactions with the physical environment (waves) through their social lens (personal experiences). Although most surfers agreed upon the conditions that make good surf, they had different perceptions of how surf has changed through time and how they expect it to change based on predictions presented to them. Surfing at Honoli‘i is a social activity and the presence of friends, family, a new demographics of surfers, weather conditions, and nostalgia intertwine to define how a surfer remembers "good surf". Honoli‘i has been a surf spot for centuries, as described in Hawaiian legends, and this potential to persist is expected. The place attachment that surfers feel toward Honoli‘i as a surf spot allows their dedication to surf to continue regardless of surf conditions. Surfers are adaptive to changing surf conditions because their social expectations shift alongside their physical surf expectations. Research to understand recreationalist understanding and perception of environmental change is scarce and this project revealed the importance of working with observers directly connected to environmental resources. Our ability to respond to climate change is directly linked to the communities' perception of the impact and their internalization of effects. Disregarding climate change perceptions by those observers connected directly to the environment will impede any progress of mitigation or education regarding climate change impacts.
3. *Ocean Presence* – Understanding how many people access our shoreline areas would be a huge task if the dataset provided by the County ocean safety division did not exist. Yet, this dataset has never been digitized or accessed by the public before, nor has it been analyzed by the County for rates or trends other than yearly end totals. The digitization of this dataset has allowed us to see the trends in beach use along popular County beaches in East Hawai‘i and through further statistical analysis we will be able to visualize comparable trends and begin to see patterns of beach attendance. Hawai‘i is home to ocean people yet we live in a global society. Are we losing our connection and reliance on our ocean resources? Is climate change presenting new challenges or creating conditions that will increase the amount of people on our shorelines? These questions are important staffing questions for the County division, but they are also important questions as we persist in our connection (or disconnection) from the ocean. Analysis of this information has direct management implications for the County Ocean Safety Division as they implement staffing and procedural regulations along our coastlines in this time of change.
4. *Definition of Seascapes* – Cross-comparison of experiences, perceptions, and values allows a deeper understanding of the importance of the ocean. By working with colleagues in the Atlantic, we can see both how unique our cultures are, and yet where similarities exist. To understand a shift in understanding or behavior, we must first have baselines in which comparisons can be made. Our interviews with people who have a strong connection to the ocean, and primarily in Hilo, allowed us to see how their love of the ocean in their daily lives defines their behaviors and

has shaped their perception of environmental change. Our interviewees spend consistent time in this environment and will be the ones to alert us when conditions change.

8. Conclusions and Recommendations

We are inspired by the results generated from relatively simple social science research methods into understanding communication of climate change results. The inclusion of the community and their perspectives in understanding how climate change will impact "us" and ocean users was relatively simple to collect. The participatory research approach allowed us flexibility to listen to the experiences of these ocean users and in doing so, our scope of study was expanded to areas outside of Hilo Bay. Continuing interviews and participatory research with these communities directly tied to their environment will build capacity in our communities and management agencies.

Local managers have the benefit of being closely connected to the communities they serve. Building upon their personal relationships, intrinsic knowledge of the environment, and working with locally engaged community groups they are well positioned to integrate qualitative environmental knowledge. The trust gained through such a process assists in building resiliency and connects people directly to the environment, challenging them to become active observers and participants in local governance. Participation in governance and management empowers our community and prepares them for climate adaptation.

By listening to our ocean experts, we have discovered many new pathways of research regarding ocean patterns and change and are excited to continue this research. An example would be to focus on the insights and environmental knowledge of the younger generations. Although interviews are usually conducted with kūpuna (elders), we interviewed young surfers, lifeguards, and fisherman about their experiences and connection to the ocean. I think this approach is interesting because it allows us to see current perceptions and understandings of the ocean which can then be directly compared to the perceptions of an older generation. It also empowers them to be constant observers and participants in an informed society where they have knowledge that can be shared and maintained. Although we are proud in the depth and breadth of data collected through this project, analysis of all the data was not completed as expected. However our focus on quality control was important to ensure confidence in the data digitized and recorded.

9. Management Applications and Products

Pakalove and the Hawaii County Ocean Safety Division were very supportive partners in this project. By working directly with agencies and community groups that are tied to the resources we ensure that the research and results are immediately available. Pakalove is a non-profit organizations that promotes healthy living, kuleana to place, and respect in the surf culture. As part of our process in identifying ocean experts and in creation of our surf surveys, we participated in community outreach events and tested the methods, inquired about relevance, and refined questions. Speaking directly with surfers and their families was engaging and allowed us to have meaningful conversations on ocean conditions, changes witnessed and specific variables that create desirable ocean conditions.

More analysis must be conducted before the ocean user data can be easily used by the Ocean Safety Division, yet thus far they have been supportive of our research questions and the implications of the

data. They are interested in seeing the trends in ocean users and the variables that guide people's access to the shoreline. By knowing how to predict future ocean use, the division can better prepare their ocean safety personnel in staffing and educational training.

10. Outreach

Publications

Puniwai N, Gray S, Lepczyk CA. Climate Change Forecast's Influence On Recreation In Hawai'i. In prep. 2016

Puniwai N, Gray S, Lepczyk CA, Kapono A, Severance C. Mapping Ocean Currents Through Human Observations: Insights from Hilo Bay, Hawai'i. Human Ecology. 2016:1-10.

Presentations

Puniwai, Noelani and Parrain, Camille. "Seascape Identities: Understanding Values and Cultural Patterns". International Coral Reef Symposium. Honolulu, HI. June 19-24, 2016.

Kalua, M., Takabayashi, M. Ku'ula Students, Tangaro, T. " 'Uku 'Ako'ako'a: Kin relationships between the coral and people in Native Hawaiian Epistemology". International Coral Reef Symposium. Honolulu, HI. June 19-24, 2016.

Puniwai, Noelani. "Recreational Seascapes: Integrating Human and Mechanical Observations on Hawai'i Island". Webinar. National Climate Change and Wildlife Science Center. April 26th, 2016.

Kauahi, Cherie and Puniwai, N. "Cultural seascapes of Keaukaha, Hawai'i. Poster presentation: International Coastal and Marine Tourism Conference. Waikoloa, HI. November 10-12th 2015.

Kung, Stephanie and Puniwai, N. "Projections of surf quality with climate change". Poster presentation: International Coastal and Marine Tourism Conference. Waikoloa, HI. November 10-12th 2015.

Puniwai, N., Gray, S., Lepczyk, C. " 'Ike i ke au nui ke au iki - Assessing Cultural Seascapes in Hawai'i". Mellon Fellow Presentation, University of Hawai'i at Hilo. May 2015.

Puniwai, N., and Genz, A. "Implications for Ocean Recreation with a Changing Seascape". Poster presentation: Pacific Islands Climate Science Symposium. Honolulu, HI. February 26-27th 2015.

Puniwai, N., Gray, S., Lepczyk, C. " 'Ike i ke au nui ke au iki - Assessing Cultural Seascapes in Hawai'i". Mellon Fellow Presentation, Keauhou, Kona. November 2014.

Puniwai, N., Gray, S., Lepczyk, C. and Kapono, T. "Hawaiian Cultural Seascapes: Perspectives from paddlers, fishers, and surfers in Hilo Bay". XX International Conference of the Society for Human Ecology – Session on Human dimensions of Marine Systems. Bar Harbor, Maine. October 22-25th, 2014.

Puniwai, N., Gray, S., and Lepczyk, C. "Hawaiian Cultural Seascapes: Perspectives from paddlers and surfers in Hilo Bay." Pathways Conference: Integrating Human Dimensions into Fish and Wildlife Management. Estes Park, Colorado. October 5-9th 2014.

Connections with Resource Managers, Decision-Makers, and Community or Cultural Stewards

Connections with managers were made on multiple scales during this timeframe. Starting from the top, resource managers and decision-makers at the regional, national, and international level were presented with the face-to-face methodology and results in which this research is based through presentations as listed in the previous section. The basic premise that knowledge gained from interviews can be used in spatially managing and understanding a resource has been demonstrated. These public presentations were well received and valuable feedback was provided.

The Honoli‘i Pakalove Fest, January 31st – February 1st 2015 was well attended by both surf professionals, surfers, families, and community educators. We presented information on climate change patterns particular to Hilo and Honoli‘i through large wall displays and interactive games. The games allowed us to help the students analyze trends such as rainfall, streamflow, wave and wind strength. We also passed out the SeaGrant publication “Climate Change and Hawaii” and had open conversations with all in attendance. Two weeks later we presented these climate change patterns of Hilo again at the Aloha Kanaloa Festival on Moku Ola. Attendance at these events allows us to connect with community members that have passion for our resources and have the desire to be educated on environmental and human resource issues. In late May 2015, 40 student interns, project staff, and site managers focused on seascapes in Kahalu’u Kona. By looking at a place with a social and physical lens, students investigated climate change implications on a small coastal area. Communication regarding this process was advertised by PICSC communication coordinator Sarah Nash in early June.

Similar outreach efforts were planned in coordination of Hakalau Fest and Honoli‘i Pakalove, but due to the inclement weather, these events were repeatedly cancelled for both fall 2015 and spring 2016. Future outreach regarding the products of this research will be communicated as opportunities arise.